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**PART F-2**  
**STORAGE AND HANDLING OF ANHYDROUS AMMONIA**

**WAC**

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**WAC 296-24-510 Storage and handling of anhydrous ammonia.**

[Order 73-5, § 296-24-510, filed 5/9/73 and Order 73-4, § 296-24-510, filed 5/7/73.]

**WAC 296-24-51001 Scope.**

- (1) This standard is intended to apply to the design, construction, location, installation, and operation of anhydrous ammonia systems including refrigerated ammonia storage systems.
- (2) This standard does not apply to:
  - (a) Ammonia manufacturing plants.
  - (b) Refrigeration plants where ammonia is used solely as a refrigerant. Such systems are covered in American National Standard Safety Code for Mechanical Refrigeration, B-9.1. (See Appendix C for availability.) The provisions of ANSI B-9.1 are not appropriate to refrigerated ammonia storage systems as covered in this standard.
  - (c) Ammonia transportation pipelines.

[Order 73-5, § 296-24-51001, filed 5/9/73 and Order 73-4, § 296-24-51001, filed 5/7/73.]

**WAC 296-24-51003 General.**

- (1) The term “**anhydrous ammonia**” as used in this standard refers to the compound formed by a combination of two gaseous elements, nitrogen and hydrogen, in the proportion of one part nitrogen to three parts hydrogen by volume. Anhydrous ammonia may be in either gaseous or liquid form. It is not to be confused with aqua ammonia which is a solution of ammonia gas in water. Whenever the term “**ammonia**” appears in this standard, it is understood to mean anhydrous ammonia.
- (2) It is important that personnel understand the properties of this gas and that they be thoroughly trained in safe practices for its storage and handling. Some of the important physical properties of ammonia are listed in (4) of this section.

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- (3) Gaseous ammonia liquefies under pressure at ambient temperature. Advantage of this characteristic is taken by industry and for convenience this commodity is usually shipped and stored under pressure as a liquid. When refrigerated to or below its normal boiling point (-28°F) it may be shipped and stored as a liquid at atmospheric pressure.

- (4) Physical properties of ammonia:

Molecular symbol	NH <sub>3</sub>
Molecular weight	17.032
Boiling point at one atmosphere (one atmosphere = 14.7 psia)	-28°F
Melting point at one atmosphere	-107.9°F
Critical temperature	271.4°F
Critical pressure	1657 psia
Latent heat at -28°F and one atmosphere	589.3 BTU per pound
Relative density of vapor compared to dry air at 32°F and one atmosphere	0.5970
Vapor density at -28°F and one atmosphere	0.05555 lb. per cu. ft.
Specific gravity of liquid at -28°F compared to water at 39.2°F	0.6819
Liquid density at 28°F and one atmosphere	42.57 lb. per cu. ft.
Specific volume of vapor at 32°F and one atmosphere	20.78 cu. ft. per pound
Flammable limits by volume in air at atmospheric pressure	16% to 25%
Ignition temperature (in a standard quartz container)	1562°F
Specific heat, gas, 15 C, one atm at constant pressure, C <sub>p</sub>	0.5232 Btu/lb. degree °F
at constant volume, C <sub>v</sub>	0.3995 Btu/lb. degree °F

- (5) Experience has shown that ammonia is extremely hard to ignite and under normal conditions is a very stable compound. It takes temperatures of 840-930°F to cause it to dissociate slightly at atmospheric pressure. The flammable limits at atmospheric pressure are 16% to 25% by volume of ammonia in air. Experiments conducted by a nationally recognized laboratory indicated that an ammonia-air mixture in a standard quartz test container does not ignite below 1562°F. Ammonia is classified by the United States Department of Transportation and the U.S. Coast Guard as a nonflammable compressed gas for the purpose of transportation.
- (6) Ammonia should be handled only by properly trained personnel. In no case shall ammonia be used in conjunction with chemicals unless the possible reactions have first been adequately investigated. Under some circumstances ammonia and ammonium compounds can form explosive products with other chemicals. For additional information refer to NFPA 491M "Manual on Hazardous Chemical Reactions" (see Appendix C for availability) and CG-388, the "Chemical Data Guide for Bulk Shipment by Water" (1969 Edition).
- (7) Ammonia gas irritates the skin and mucous membrane. At 50 ppm its odor is detectable by most people. The maximum allowable concentration for an 8 hour working exposure is specified as 50 PPM by the American Conference of Government Industrial Hygienists. Because it serves as its own warning agent, no person will voluntarily remain in concentrations which are hazardous. At 5000 ppm it is rapidly fatal. Since ammonia gas is lighter than air, adequate ventilation is the best means of preventing any accumulation.
- (8) The common metals are not attacked by dry ammonia. Zinc, copper and copper base alloys such as brass are subject to rapid destructive action by ammonia in the presence of water.

[Order 73-5, § 296-24-51003, filed 5/9/73 and Order 73-4, § 296-24-51003, filed 5/7/73.]

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**WAC 296-24-51005 Definitions.** The following definitions are applicable to all sections of this chapter which include WAC 296-24-510 in the section number and shall be construed to have the meanings below.

- (1) **“Approved”** as used in these standards means:
  - (a) Listed by a recognized testing laboratory, or
  - (b) Recommended by the manufacturer as suitable for use with anhydrous ammonia and so marked, or
  - (c) Accepted by the authority having jurisdiction.
- (2) **“Appurtenance”** refers to all devices such as pumps, compressors, safety relief devices, liquid-level gaging devices, valves and pressure gages.
- (3) **“Capacity”** refers to the total volume of the container measured in U.S. gallons, unless otherwise specified.
- (4) **“Cylinder”** means a container of 1000 pounds water capacity or less constructed in accordance with United States Department of Transportation Specifications.
- (5) The **“code”** refers to the Unfired Pressure Vessel Code of the American Society of Mechanical Engineers (Section VIII of the ASME Boiler Construction Code), 1952, 1956, 1959, 1962, 1965, 1968 and 1971 editions, the joint code of the American Petroleum Institute and the American Society of Mechanical Engineers (API-ASME Code) 1951 edition, and subsequent amendments to or later editions of the same, as adopted.
- (6) **“Container”** includes all vessels, tanks, cylinders or spheres used for transportation, storage or application of anhydrous ammonia.
- (7) **“Design pressure”** is identical to the term “maximum allowable working pressure” used in the code.
- (8) An **“implement of husbandry”** is a farm wagon-type tank vehicle of not over 3000 gallons capacity, used as a field storage “nurse tank” supplying the fertilizer to a field applicator and moved on highways only for bringing the fertilizer from a local source of supply to farms or fields or from one farm or field to another.
- (9) **“Filling density”** means the per cent ratio of the weight of the gas in a container to the weight of water at 60°F that the container will hold. One lb. H<sub>2</sub>O = 27.737 cu. in. at 60°F. For determining the weight capacity of the tank in pounds, the weight of a gallon (231 cubic inches) of water at 60°F in air shall be 8.32828 pounds.
- (10) **“Gas”** refers to anhydrous ammonia in either the gaseous or liquefied state.
- (11) **“Gas mask”** refers to gas masks approved by the Mine Safety and Health Administration (MSHA) and the National Institute for Occupational Safety and Health (NIOSH).
- (12) **“DOT regulations”** refer to hazardous materials regulations of the department of transportation (Title 49-Transportation, Code of Federal Regulations, Parts 171 to 190), including Specifications for Shipping Containers.
- (13) **“Systems”** as used in these standards refers to an assembly of equipment consisting essentially of the container or containers, appurtenances, pumps, compressors, and interconnecting piping.

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**WAC 296-24-51005 (Cont.)**

- (14) The abbreviations **“psig”** and **“psia”** refer to pounds per square inch gage and pounds per square inch absolute, respectively.
- (15) The terms **“charging”** and **“filling”** are used interchangeably and have the same meaning.
- (16) **“Trailer”** as used in these standards refers to every vehicle designed for carrying property and for being drawn by a motor vehicle and so constructed that no part of its weight except the towing device rests upon the towing vehicle.
- (17) **“Tank motor vehicle”** means any motor vehicle designed or used for the transportation of anhydrous ammonia in any tank designed to be permanently attached to any motor vehicle or any container not permanently attached to any motor vehicle which by reason of its size, construction or attachment to any motor vehicle must be loaded and/or unloaded without being removed from the motor vehicle.
- (18) **“Semitrailer”** refers to every vehicle designed for carrying property and for being drawn by a motor vehicle and so constructed that some part of its weight and that of its load rests upon or is carried by another vehicle.
- (19) **“Safety relief valve”** refers to an automatic spring loaded or equivalent type pressure activated device for gas or vapor service characterized by pop action upon opening, sometimes referred to as a pop valve. (Refer to American National Standards Institute, Terminology for Pressure Relief Devices, B95.1.)
- (20) **“Hydrostatic relief valve”** refers to an automatic pressure activated valve for liquid service characterized by throttle or slow weep opening (nonpop action). (Refer to American National Standards Institute, Terminology for Pressure Relief Devices, B95.1.)

[Statutory Authority: RCW 49.17.010, .040, .050. 99-10-071 (Order 98-10), § 296-24-51005, filed 05/04/99, effective 09/01/99.  
Statutory Authority: Chapter 49.17 RCW. 94-15-096 (Order 94-07), § 296-24-51005, filed 7/20/94, effective 9/20/94; Order 74-27, § 296-24-51005, filed 5/7/74; Order 73-5, § 296-24-51005, filed 5/9/73 and Order 73-4, § 296-24-51005, filed 5/7/73.]

**WAC 296-24-51007 Use of water in emergencies.**

- (1) The concentration of ammonia vapor in air can effectively be reduced by the use of adequate volumes of water applied through spray or fog nozzles.
- (2) Water should be used on liquid ammonia spills only if sufficient water is available. For the purpose of this section, sufficient water may be taken to be 100 parts of water to one part of ammonia.
- (3) If an ammonia container is exposed to fire and cannot be removed, water should be used to cool it.
- (4) Under some circumstances ammonia in a container is colder than the available water supply. Under these circumstances water should not be sprayed on the container walls since it would heat the ammonia and aggravate any gas leak.
- (5) If it is found necessary to dispose of ammonia, as from a leaking container, liquid ammonia should be discharged into a vessel containing water sufficient to absorb it. Sufficient water may be taken to be ten parts of water per part ammonia. The ammonia should be injected into the water as near the bottom of the vessel as practical.

[Order 73-5, § 296-24-51007, filed 5/9/73 and Order 73-4, § 296-24-51007, filed 5/7/73.]

**WAC 296-24-51009 Basic rules.** This section applies to all sections of this chapter which include WAC 296-24-510 in the section number unless otherwise noted.

- (1) Approval of equipment and systems. Each appurtenance shall be approved in accordance with (a), (b), (c), and (d) of this subsection.

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**WAC 296-24-51009 (Cont.)**

- (a) It was installed before February 8, 1973 and was approved and tested, and installed in accordance with either the provisions of the American National Standard for the Storage and Handling of Anhydrous Ammonia, K61.1, or the Fertilizer Institute Standards for the Storage and Handling of Agricultural Anhydrous Ammonia, M-1, in effect at the time of installation; or
  - (b) It is accepted, or certified, or listed, or labeled, or otherwise determined to be safe by a nationally recognized testing laboratory; or
  - (c) It is a type which no nationally recognized testing laboratory does, or will undertake to accept, certify, list, label, or determine to be safe; and such equipment is inspected or tested by any federal, state, municipal, or other local authority responsible for enforcing occupational safety provisions of a federal, state, municipal or other local law, code, or regulation pertaining to the storage, handling, transport, and use of anhydrous ammonia, and found to be in compliance with either the provisions of the American National Standard for the Storage and Handling of Anhydrous Ammonia, K61.1, or the Fertilizer Institute Standards for the Storage and Handling of Agricultural Anhydrous Ammonia, M-1, in effect at the time of installation; or
  - (d) It is a custom-designed and custom-built unit, which no nationally recognized testing laboratory, or federal, state, municipal or local authority responsible for the enforcement of a federal, state, municipal, or local law, code or regulation pertaining to the storage, transportation and use of anhydrous ammonia is willing to undertake to accept, certify, list, label or determine to be safe, and the employer has on file a document attesting to its safe condition following the conduct of appropriate tests. The document shall be signed by a registered professional engineer or other person having special training or experience sufficient to permit him/her to form an opinion as to safety of the unit involved. The document shall set forth the test bases, test data and results, and also the qualifications of the certifying person.
  - (e) For the purposes of this section the word **“listed”** means that equipment is of a kind mentioned in a list which is published by a nationally recognized laboratory which makes periodic inspection of the production of such equipment, and states such equipment meets nationally recognized standards or has been tested and found safe for use in a specified manner. **“Labeled”** means there is attached to it a label, symbol, or other identifying mark of a nationally recognized testing laboratory which makes periodic inspections of the production of such equipment, and whose labeling indicates compliance with nationally recognized standards or tests to determine safe use in a specified manner. **“Certified”** means it has been tested and found by a nationally recognized testing laboratory to meet nationally recognized standards or to be safe for use in a specified manner, or is of a kind whose production is periodically inspected by a nationally recognized testing laboratory, and it bears a label, tag, or other record of certification.
  - (f) For purposes of this section, refer to federal regulation 29 CFR 1910.7 for definition of nationally recognized testing laboratory.
- (2) Requirements for construction, original test and requalification of not-refrigerated containers.
- (a) Containers used with systems covered in WAC 296-24-51011 and 296-24-51017 through 296-24-51021 shall be constructed and tested in accordance with the code except that construction under Table UW-12 at a basic joint efficiency of under eighty percent is not authorized.

Containers built according to the code do not have to comply with paragraphs UG-125 to UG-128, inclusive, and paragraphs UG-132 and UG-133 of the code.

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**WAC 296-24-51009 (Cont.)**

- (b) Containers exceeding thirty-six inches in diameter or two hundred fifty gallons water capacity shall be constructed to comply with one or more of the following:
    - (i) Containers shall be stress relieved after fabrication in accordance with the code, or
    - (ii) Cold-formed heads, when used, shall be stress relieved or,
    - (iii) Hot-formed heads shall be used.
  - (c) Welding to the shell, head, or any other part of the container subject to internal pressure shall be done in compliance with WAC 296-24-51005(5). Other welding is permitted only on saddle plates, lugs, or brackets attached to the container by the container manufacturer.
  - (d) Containers used with systems covered by subsection (3)(b)(iv) of this section shall be constructed and tested in accordance with the DOT specifications.
  - (e) The provisions of (a) of this subsection shall not be construed as prohibiting the continued use or reinstallation of containers constructed and maintained in accordance with the 1949, 1950, 1952, 1956, 1959, 1962, 1965 and 1968 editions of the Unfired Pressure Vessel Code of the ASME or any revisions thereof in effect at the time of fabrication.
- (3) Markings on nonrefrigerated containers and systems other than DOT containers.
- (a) System nameplates, when required, shall be permanently attached to the system so as to be readily accessible for inspection and shall include markings as prescribed in (b) of this subsection.
  - (b) Each container or system covered in WAC 296-24-51011, 296-24-51017, 296-24-51019 and 296-24-51021 shall be marked as specified in the following:
    - (i) With a marking identifying compliance with the rules of the code under which the container is constructed.
    - (ii) With a notation on the container and system nameplate when the system is designed for underground installation.
    - (iii) With the name and address of the supplier of the container or the trade name of the container and with the date of fabrication.
    - (iv) With the water capacity of the container in pounds at 60°F or gallons, United States standard.
    - (v) With the design pressure in pounds per square inch gage.
    - (vi) With the wall thickness of the shell and heads.
    - (vii) With marking indicating the maximum level to which the container may be filled with liquid anhydrous ammonia at temperatures between 20°F and 100°F except on containers provided with fixed maximum level indicators, such as fixed length dip tubes, or containers that are filled by weight. Markings shall be in increments of not more than 20°F.

**WAC 296-24-51009 (Cont.)**

- (viii) With the outside surface area in square feet.
  - (ix) With minimum temperature in Fahrenheit for which the container is designed.
  - (x) Marking specified on container shall be on the container itself or on a nameplate permanently affixed thereto.
- (c) All main operating valves on permanently installed containers having a capacity of over three thousand water gallons shall be identified to show whether the valve is in liquid or vapor service. The recommended method of identification may be legend or color code as specified in (c)(i) and (ii) of this subsection:
- (i) Legend: The legend **liquid** (or **liquid valve**), **vapor** (or **vapor valve**), as appropriate, shall be placed on or within twelve inches of the valve by means of a stencil tag, or decal.
  - (ii) Color code: Liquid valves shall be painted orange and vapor valves shall be painted yellow. The legend **orange-liquid**, **yellow-vapor** shall be displayed in one or more conspicuous places at each permanent storage location. The legend shall have letters at least two inches high and shall be placed against a contrasting background. This is in accordance with American National Standard A13.1 "Schemes for Identification of Piping Systems"-1956, Page 5.
- (4) Marking refrigerated containers. (See WAC 296-24-51013(3). Marking refrigerated containers.)
- (5) Location of containers.
- (a) Consideration shall be given to the physiological effects of ammonia as well as to adjacent fire hazards in selecting the location for a storage container. Containers shall be located outside of buildings or in buildings or sections thereof especially approved for this purpose.
  - (b) Containers shall be located at least fifty feet from a dug well or other sources of potable water supply, unless the container is a part of a water treatment installation.
  - (c) The location of permanent storage containers shall be outside densely populated areas.
  - (d) Container locations shall comply with the following table:

Minimum Distances (feet) From Container to:			
Normal Capacity of Container	Line of Adjoining Property which may be built upon Highways & Mainline of Railroad	Place of Public Assembly	Institution Occupancy
Over 500 to 2,000	25	150	250
Over 2,000 to 30,000	50	300	500
Over 30,000 to 100,000	50	450	750
Over 100,000	50	600	1,000

- (e) Storage areas shall be kept free of readily ignitable materials such as waste, weeds and long dry grass.

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**WAC 296-24-51009 (Cont.)**

- (6) Container appurtenances.
- (a) All appurtenances shall be designed for not less than the maximum working pressure of that portion of the system on which they are installed. All appurtenances shall be fabricated from materials proved suitable for anhydrous ammonia service.
  - (b) All connections to containers except safety relief devices, gaging devices, or those fitted with a No. 54 drill size orifice shall have shutoff valves located as close to the container as practicable.
  - (c) Excess flow valves where required by these standards shall close automatically at the rated flows of vapor or liquid as specified by the manufacturer. The connections and line including valves and fittings being protected by an excess flow valve shall have a greater capacity than the rated flow of the excess flow valve.
  - (d) Liquid level gaging devices that require bleeding of the product to the atmosphere and which are so constructed that outward flow will not exceed that passed by a No. 54 drill size opening need not be equipped with excess flow valves.
  - (e) Openings from container or through fittings attached directly on container to which pressure gage connections are made need not be equipped with excess flow valves if such openings are not larger than No. 54 drill size.
  - (f) Excess flow and back pressure check valves where required by these standards shall be located inside of the container or at a point outside as close as practicable to where the line enters the container. In the latter case, installation shall be made in such manner that any undue stress beyond the excess flow or back pressure check valve will not cause breakage between the container and the valve.
  - (g) Excess flow valves shall be designed with a bypass, not to exceed a No. 60 drill size opening to allow equalization of pressures.
  - (h) Shutoff valves provided with an excess flow valve shall be designed for proper installation in a container connection so that the excess flow valve will close should the shutoff valve break.
  - (i) All excess flow valves shall be plainly and permanently marked with the name or trademark of the manufacturer, the catalog number, and the rated capacity.
- (7) Piping, tubing and fittings.
- (a) All piping, tubing and fittings shall be made of material suitable for anhydrous ammonia service.
  - (b) All piping, tubing and fittings shall be designed for a pressure not less than the maximum pressure to which they may be subjected in service.
  - (c) All piping shall be well supported and provision shall be made for expansion and contraction. All refrigeration system piping shall conform to the Refrigeration Piping Code (ANSI B31.5 1966 addenda B31.1a-1968), a section of the American Standard Code for Pressure Piping, as it applies to ammonia.



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**WAC 296-24-51009 (Cont.)**

- (d) Piping used on nonrefrigerated systems shall be at least ASTM A-53-1969 Grade B Electric Resistance Welded and Electric Flash Welded Pipe or equal. Such pipe shall be at least Schedule 40 when joints are welded, or welded and flanged. Such pipe shall be at least Schedule 80 when joints are threaded. Brass, copper, or galvanized steel pipe or tubing shall not be used.
  - (e) All metal flexible connections for permanent installations shall have a minimum working pressure of 250 p.s.i.g. (safety factor of 4). For temporary installations, hose meeting the requirement of subsection (8) of this section may be used.
  - (f) Cast iron fittings shall not be used but this shall not prohibit the use of fittings made specially for ammonia service of malleable or nodular iron such as Specification ASTM A47 or ASTM A395.
  - (g) Provisions shall be made for expansion, contraction, jarring, vibration, and for settling.
  - (h) Adequate provisions shall be made to protect all exposed piping from physical damage that might result from moving machinery, the presence of automobiles or trucks, or any other undue strain that may be placed upon the piping.
  - (i) Joint compounds shall be resistant to ammonia.
  - (j) After assembly, all piping and tubing shall be tested and proved to be free from leaks at a pressure not less than the normal operating pressure of the system.
- (8) Hose specification.
- (a) Hose used in ammonia service and subject to container pressure shall conform to the joint Rubber Manufacturers Association and the Fertilizer Institute "Hose Specifications for Anhydrous Ammonia" (see Appendix B).
  - (b) Hose subject to container pressure shall be designed for a minimum working pressure of 350 p.s.i.g. and a minimum burst pressure of 1750 p.s.i.g. Hose assemblies, when made up, shall be capable of withstanding a test pressure of 500 p.s.i.g.
  - (c) Hose and hose connections located on the low pressure side of flow control or pressure reducing valves on devices discharging to atmospheric pressure shall be designed for the maximum low side working pressure. All connections shall be designed, constructed, and installed so that there will be no leakage when connected.
  - (d) Where liquid transfer hose is not drained of liquid upon completion of transfer operations, such hose shall be equipped with an approved shutoff valve at the discharge end. Provision shall be made to prevent excessive hydrostatic pressure in the hose. (See subsection (9)(j) of this section.)
  - (e) On all hose one-half inch O.D. and larger, used for the transfer of anhydrous ammonia liquid or vapor, there shall be etched, cast, or impressed at five-foot intervals the following information:

**"Anhydrous Ammonia"**  
**xxx p.s.i.g. (Maximum working pressure)**  
**Manufacturer's Name or Trademark**  
**Year of Manufacture**

**WAC 296-24-51009 (Cont.)**

(9) Safety relief devices.

- (a) Every container used in systems covered by WAC 296-24-51011, 296-24-51017, 296-24-51019 and 296-24-51021 shall be provided with one or more safety relief valves of the spring-loaded or equivalent type. The discharge from safety relief valves shall be vented away from the container, upward and unobstructed to the atmosphere. All safety relief valve discharge openings shall have suitable raincaps that will allow free discharge of the vapor and prevent the entrance of water. Provision shall be made for draining condensate which may accumulate. The rate of the discharge shall be in accordance with the provisions of Appendix A.
- (b) Container safety relief valves shall be set to start-to-discharge as follows, with relations to the design pressure of the container.

Containers	Minimum	Maximum*
ASME U-68, U-69	110%	125%
ASME U-200, U-201	95%	100%
ASME 1952, 1956, 1959, 1962, 1965, 1968, or 1971	95%	100%
API-ASME	95%	100%
U.S. Coast Guard	(As required by U.S.CG regulations)	
DOT	(As required by DOT regulations)	

*\*Note: A relief valve manufacturer's tolerance of plus ten percent is permitted.*

- (c) Safety relief devices used in systems covered by WAC 296-24-51011, 296-24-51017, 296-24-51019 and 296-24-51021 shall be constructed to discharge at not less than the rates required in (a) of this subsection before the pressure is in excess of one hundred twenty percent (not including the ten percent tolerance referred to in (b) of this subsection) of the maximum permitted start-to-discharge pressure setting of the device.
- (d) Safety relief valves shall be so arranged that the possibility of tampering will be minimized. If the pressure setting adjustment is external, the relief valves shall be provided with means for sealing the adjustment.
- (e) Shutoff valves shall not be installed between the safety relief valves and the containers or systems described in WAC 296-24-51011, 296-24-51017, 296-24-51019 and 296-24-51021, except that a shutoff valve may be used where the arrangement of this valve is such as always to afford required capacity flow through the relief valves.

*Note: The above exception is made to cover such cases as a three-way valve installed under two safety relief valves, each of which has the required rate of discharge and is so installed as to allow either of the safety relief valves to be closed off, but does not allow both safety valves to be closed off at the same time. Another exception to this may be where two separate relief valves are installed with individual shutoff valves. In this case, the two shutoff valve stems shall be mechanically interconnected in a manner which will allow full required flow of one safety relief valve at all times. Still another exception is a safety relief valve manifold which allows one valve of two, three, four or more to be closed off and the remaining valve or valves will provide not less than the rate of discharge shown on the manifold nameplate.*

- (f) Safety relief valves shall have direct communication with the vapor space of the container.
- (g) Each safety relief valve used with systems described in WAC 296-24-51011, 296-24-51017, 296-24-51019 and 296-24-51021 shall be plainly and permanently marked as follows:

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**WAC 296-24-51009 (Cont.)**

- (i) With the letters "AA" or the symbol "NH<sub>3</sub>."
- (ii) The pressure in pounds per square inch gage (p.s.i.g.) at which the valve is set to start-to-discharge.
- (iii) The rate of discharge of the valve in cubic feet per minute of air at 60°F and atmospheric pressure (14.7 p.s.i.a.).
- (iv) The manufacturer's name and catalog number.

For example, a safety relief valve marked AA-250-4200 (air) would mean that this valve is suitable for use on an anhydrous ammonia container; that it is set to start-to-discharge at 250 p.s.i.g.; and that its rate of discharge (see subsection (8)(a) through (c) of this section) is four thousand two hundred cubic feet per minute of air.

- (h) The flow capacity of the safety relief valve shall not be restricted by any connection to it on either the upstream or downstream side.
  - (i) The manufacturer or supplier of a safety relief valve manifold shall publish complete data showing the flow rating through the combined assembly of the manifold with safety relief valves installed. The manifold flow rating shall be determined by testing the manifold with all but one valve discharging. If one or more openings have restrictions not present in the remaining openings, the restricted opening or openings or those having the lowest flow shall be used to establish the flow rate marked on the manifold nameplate. The marking shall be similar to that required in (g) of this subsection for individual valves.
  - (j) A hydrostatic relief valve shall be installed between each pair of valves in the liquid ammonia piping or hose where liquid may be trapped so as to relieve into the atmosphere at a safe location.
  - (k) Discharge from safety relief devices shall not terminate in or beneath any building.
- (10) Safety. See CGA Pamphlet G-2, TFI Operational Safety Manual M-2 and MCA Safety Data Sheet SD-8 (see Appendix C for availability).
- (a) Personnel required to handle ammonia shall be trained in safe operating practices and the proper action to take in the event of emergencies. Personnel shall be instructed to use the equipment listed in (c) of this subsection in the event of an emergency. (Rev. 1-22-76)
  - (b) If a leak occurs in an ammonia system, the personnel trained for and designated to act in such emergencies shall:
    - (i) See that persons not required to deal with an emergency are evacuated from the contaminated area.
    - (ii) Put on a suitable gas mask.
    - (iii) Wear gauntlet type plastic or rubber gloves and wear plastic or rubber suits in heavily contaminated atmospheres.
    - (iv) Shut off the appropriate valves.

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**WAC 296-24-51009 (Cont.)**

- (c) All stationary storage installations shall have at least:
    - (i) Two suitable gas masks in readily accessible locations. Full face masks with ammonia canisters as certified by NIOSH under 42 CFR Part 84, are suitable for emergency action for most leaks, particularly those that occur outdoors. For protection in concentrated ammonia atmospheres self-contained breathing apparatus is required.
    - (ii) One pair of protective gloves made of rubber or other material impervious to ammonia.
    - (iii) One pair of protective boots made of rubber or other material impervious to ammonia.
    - (iv) One protective slicker and/or protective pants and jacket made of rubber or other material impervious to ammonia.
    - (v) Easily accessible shower and/or at least fifty gallons of clean water in an open top container.
    - (vi) Tight fitting vented goggles or one full face shield.
  - (d) Where several persons are usually present, additional safety equipment may be desirable.
  - (e) Each tank motor vehicle transporting anhydrous ammonia, except farm applicator vehicles, shall carry a container of at least five gallons of water and shall be equipped with a full face gas mask, a pair of tight-fitting goggles or one full face shield. The driver shall be instructed in their use and the proper action to take to provide for his/her safety.
  - (f) If a leak occurs in transportation equipment and it is not practical to stop the leak, the driver should move the vehicle to an isolated location away from populated communities or heavily traveled highways.
  - (g) If liquid ammonia contacts the skin or eyes, the affected area should be promptly and thoroughly flushed with water. Do not use neutralizing solutions or ointments on affected areas. A physician shall treat all cases of eye exposure to liquid ammonia.
- (11) Filling densities. (See WAC 296-24-51005(9).)
- (a) The filling densities for nonrefrigerated containers shall not exceed the following:

	Aboveground	Underground
(i) Uninsulated	56%*	58%
(ii) Insulated	57%	
  - (iii) DOT containers shall be filled in accordance with DOT regulations.
- \*This corresponds to 82% by volume at -28°F, 85% by volume at 5°F, 87.5% by volume at 30°F, and 90.6% by volume at 60°F.
- (b) The filling density for refrigerated storage tanks temperature corresponding to the vapor pressure at the start-to-discharge pressure setting of the safety relief valve.

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**WAC 296-24-51009 (Cont.)**

- (c) If containers are to be filled according to liquid level by any gaging method other than a fixed length dip tube gage, each container should have a thermometer well so that the internal liquid temperature can be easily determined and the amount of liquid and vapor in the container corrected to a 60°F basis.
- (12) Transfer of liquids.
- (a) Anhydrous ammonia shall always be at a temperature suitable for the material of construction and design of the receiving containers. Ordinary steels are not suitable for refrigerated ammonia. See Appendix R of API Standard 620 "Recommended Rules for Design and Construction of Large Welded Low-Pressure Storage Tanks" for materials for low temperature service.
  - (b) At least one attendant shall supervise the transfer of liquids from the time the connections are first made until they are finally disconnected.
  - (c) Flammable gases or gases which will react with ammonia (such as air) shall not be used to unload tank cars or transport trucks.
  - (d) Containers shall be charged or used only upon authorization of the owner.
  - (e) Containers shall be gaged and charged only in the open atmosphere or in buildings approved for that purpose.
  - (f) Pumps used for transferring ammonia shall be recommended and labeled for ammonia service by the manufacturer.
    - (i) Pumps shall be designed for at least 250 p.s.i.g. working pressure.
    - (ii) Positive displacement pumps shall have installed, off the discharge port, a constant differential relief valve discharging into the suction port of the pump through a line of sufficient size to carry the full capacity of the pump at relief valve setting, which setting and installation shall be according to pump manufacturer's recommendations.
    - (iii) On the discharge side of the pump, before the relief valve line, there shall be installed a pressure gage graduated from 0 to 400 p.s.i.g.
    - (iv) Plant piping shall contain shutoff valves located as close as practical to pump connections.
  - (g) Compressors used for transferring or refrigerating ammonia shall be recommended and labeled for ammonia service by the manufacturer.
    - (i) Compressors, except those used for refrigeration, shall be designed for at least 250 p.s.i.g. working pressure. Crank cases of compressors not designed to withstand system pressure shall be protected with a suitable safety relief valve.
    - (ii) Plant piping shall contain shutoff valves located as close as practical to compressor connections.
    - (iii) A safety relief valve large enough to discharge the full capacity of the compressor shall be connected to the discharge before any shutoff valve.

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**WAC 296-24-51009 (Cont.)**

- (iv) Compressors shall have pressure gages at suction and discharge graduated to at least one and one-half times the maximum pressure that can be developed.
    - (v) Adequate means, such as drainable liquid trap, may be provided on the compressor suction to minimize the entry of liquid into the compressor.
    - (vi) Where necessary to prevent contamination, an oil separator shall be provided on the discharge side of the compressor.
  - (h) Loading and unloading systems shall be protected by suitable devices to prevent emptying of the storage container or the container being loaded or unloaded in the event of severance of the hose. Backflow check valves or properly sized excess flow valves shall be installed where necessary to provide such protection. In the event that such valves are not practical, remotely operated shutoff valves may be installed.
  - (i) Meters used for the measurement of liquid anhydrous ammonia shall be recommended and labeled for ammonia service by the manufacturer.
    - (i) Liquid meters shall be designed for a minimum working pressure of 250 p.s.i.g.
    - (ii) The metering system shall incorporate devices that will prevent the inadvertent measurement of vapor.
- (13) Tank car unloading points and operations.
- (a) Provisions for unloading tank cars shall conform to the regulations of the department of transportation.
  - (b) Unloading operations shall be performed by reliable persons properly instructed and made responsible for careful compliance with all applicable procedures.
  - (c) Caution signs shall be so placed on the track or car as to give necessary warning to persons approaching car from open end or ends of siding and shall be left up until after car is unloaded and disconnected from discharge connections. Signs shall be of metal or other suitable material, at least twelve by fifteen inches in size and bear the words "STOP—Tank car connected" or "STOP—Men at work" the word "STOP," being in letters at least four inches high and the other words in letters at least two inches high. The letters shall be white on a blue background.
  - (d) The track of a tank car siding shall be substantially level.
  - (e) Brakes shall be set and wheels blocked on all cars being unloaded.
  - (f) Tank cars of anhydrous ammonia shall be unloaded only at approved locations meeting the requirements of subsections (9)(c) and (12)(h) of this section.
- (14) Liquid level gaging device.
- (a) Each container except those filled by weight shall be equipped with an approved liquid level gaging device.
  - (b) All gaging devices shall be arranged so that the maximum liquid level to which the container is filled is readily determined. (See subsection (4)(b)(vii) of this section.)

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**WAC 296-24-51009 (Cont.)**

- (c) Gaging devices that require bleeding of the product to the atmosphere such as the rotary tube, fixed tube, and slip tube devices, shall be designed so that the maximum opening of the bleed valve is not larger than No. 54 drill size unless provided with an excess flow valve. (This requirement does not apply to farm vehicles used for the application of ammonia as covered in WAC 296-24-51021.)
- (d) Gaging devices shall have a design pressure equal to or greater than the design pressure of the container on which they are installed.
- (e) Fixed liquid level gages shall be so designed that the maximum volume of the container filled by liquid shall not exceed eighty-five percent of its water capacity. The coupling into which the fixed liquid level gage is threaded must be placed at the eighty-five percent level of the container. If located elsewhere, the dip tube of this gage must be installed in such a manner that it cannot be readily removed.

*Note: This does not apply to refrigerated storage.*

- (f) Gage glasses of the columnar type shall be restricted to stationary storage installation. They shall be equipped with shutoff valves having metallic handwheels, with excess-flow valves, and with extra heavy glass adequately protected with a metal housing applied by the gage manufacturer. They shall be shielded against the direct rays of the sun.
- (15) Painting of containers. Aboveground uninsulated containers should have a reflective surface maintained in good condition. White is recommended for painted surfaces, but other light reflecting colors are acceptable.
- (16) Electrical equipment and wiring.
- (a) Electrical equipment and wiring for use in ammonia installations shall be general purpose or weather resistant as appropriate.
  - (b) Where concentrations of ammonia in air in excess of sixteen percent by volume are likely to be encountered, electrical equipment and wiring shall be of a type specified by and be installed according to chapter 296-24 WAC Part L, for Class I, Group D locations.

[Statutory Authority: RCW 49.17.010, .040, .050. 99-10-071 (Order 98-10), § 296-24-51009, filed 05/04/99, effective 09/01/99. Statutory Authority: Chapter 49.17 RCW. 91-24-017 (Order 91-07), § 296-24-51009, filed 11/22/91, effective 12/24/91; 88-23-054 (Order 88-25), § 296-24-51009, filed 11/14/88. Statutory Authority: RCW 49.17.040, 49.17.050, 49.17.240, chapters 43.22 and 42.30 RCW. 80-17-015 (Order 80-21), § 296-24-51009, filed 11/13/80; Order 76-6, § 296-24-51009, filed 3/1/76; Order 74-27, § 296-24-51009, filed 5/7/74; Order 73-5, § 296-24-51009, filed 5/9/73 and Order 73-4, § 296-24-51009, filed 5/7/73.]

**WAC 296-24-51011 Systems utilizing stationary, pier-mounted or skid-mounted aboveground or underground, nonrefrigerated storage.** This section applies to stationary, pier-mounted, skid-mounted, aboveground or underground, nonrefrigerated storage installations utilizing containers other than those constructed in accordance with department of transportation specifications. All basic rules of WAC 296-24-51009 apply to this section unless otherwise noted.

- (1) Design pressure and construction of containers. The minimum design pressure for nonrefrigerated aboveground containers shall be 250 psig. (See WAC 296-24-51009 (2)(a)(i).)

*Note: U-68 and U-69 ASME Code containers with a design pressure of 200 psig are acceptable if recertified to 250 psig and equipped with safety relief valves set at 250 psig as permitted in WAC 296-24-51009 (9)(b).*

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**WAC 296-24-51011 (Cont.)**

- (2) Container valves and accessories, filling and discharging connections.
  - (a) Each filling connection shall be provided with combination back-pressure check valve and excess flow valve; one double or two single back-pressure check valves; or a positive shutoff valve in conjunction with either an internal back-pressure check valve or an internal excess flow valve.
  - (b) All vapor and liquid connections, except safety relief valves and those specifically exempt in WAC 296-24-51009 (6)(d) and (e) shall be equipped with approved excess flow valves; or in lieu thereof, may be fitted with approved quick-closing internal valves which, except during operating periods, shall remain closed.
  - (c) Each storage container shall be provided with a pressure gage graduated from 0 to 400 psig. Gages shall be designated for use in ammonia service.
  - (d) All containers shall be equipped with an approved vapor return valve.
  - (e) All containers shall be equipped with a fixed maximum liquid level gage.
- (3) Safety relief devices.
  - (a) Every container shall be provided with one or more safety relief valves of spring-loaded or equivalent type and shall comply with the following:
    - (i) The discharge from safety relief valves shall be directed away from the container upward and unobstructed to the open air. Vent pipes shall not be restrictive or smaller in size than the safety relief outlet connection. All safety relief valve discharges shall have suitable rain caps that will allow free discharge of the vapor and prevent the entrance of water. Suitable provision shall be made for draining condensate which may accumulate.
    - (ii) If desired, vent pipes from two or more safety relief devices located on the same unit, or similar lines from two or more different units, may be run into a common header, provided the cross-sectional area of such header is at least equal to the sum of the cross-sectional areas of the individual vent pipes.
  - (b) The rate of discharge of spring-loaded safety relief valves installed on underground containers may be reduced to a minimum of 30 percent of the rate of discharge specified in Appendix A. Containers so protected shall not be uncovered after installation until the liquid ammonia has been removed. Containers which may contain liquid ammonia before being installed underground and before being completely covered with earth are to be considered aboveground containers when determining the rate of discharge requirements of the safety relief valves.
  - (c) On underground installations where there is a probability of the manhole or housing becoming flooded, the discharge from vent lines shall be located above the high water level. All manholes or housings shall be provided with ventilated louvers or their equivalent, the area of such openings equaling or exceeding combined discharge areas of safety relief valves and vent lines which discharge their content into the manhole housing.
- (4) Installation of storage containers.
  - (a) Containers installed aboveground shall be provided with substantial reinforced concrete footings and foundations or structural steel supports mounted on reinforced concrete foundations. In either



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**WAC 296-24-51011 (Cont.)**

case, the reinforced concrete foundations or footings shall extend below the established frost line and shall be of sufficient width and thickness to support the total weight of the containers and contents adequately. The foundation shall maintain the lowest point of the tank at not less than 18 inches above the ground. Floating type foundations shall also be acceptable providing the foundations are designed to adequately support the tank, contents and pumping equipment. (See WAC 296-24-51009(7).)

- (b) Horizontal aboveground containers shall be mounted on foundations in such a manner as to permit expansion and contraction. Every container shall be supported so as to prevent the concentration of excessive loads on the supporting portion of the shell. The bearing afforded by the saddles shall extend over at least one third of the circumference of the shell. Suitable means for preventing corrosion shall be provided on that portion of the container in contact with the foundations or saddles.
  - (c) Containers buried underground shall be placed so that the top of the container is at least one foot below the surface of the ground. Should ground conditions make compliance with these requirements impracticable, precautions shall be taken to prevent physical damage to the container. It is not necessary to cover the portion of the container to which a manhole and other connections are affixed when necessary to prevent floating, containers shall be securely anchored or weighted.
  - (d) Underground containers shall be set on firm foundations (firm earth may be used) and surrounded with soft earth or sand well tamped in place. As a further means of resisting corrosion, the container, prior to being placed underground, shall be given a protective coating satisfactory to the authority having jurisdiction. Such protective coating shall be equivalent to hot dip galvanizing, or to two preliminary coatings of red lead followed by a heavy coating of coal tar or asphalt. The container thus coated shall be lowered into place in such a manner as to prevent abrasion or other damage to the coating.
  - (e) Distance between aboveground and underground containers of over 1,200 gallons capacity shall be at least five feet.
  - (f) Secure anchorage or adequate pier height shall be provided against container flotation wherever sufficiently high flood water might occur.
- (5) Reinstallation of containers.
- (a) Containers once installed underground shall not later be reinstalled aboveground or underground, unless they successfully withstand hydrostatic pressure retests at the pressure specified for the original hydrostatic test as required by the code under which the tank was constructed and show no evidence of serious corrosion.
  - (b) Where containers are reinstalled underground, the corrosion resistant coating shall be put in good condition; see WAC 296-24-51011 (4)(d). Where containers are reinstalled aboveground, safety relief devices or gaging devices shall comply with WAC 296-24-51009(9) and 296-24-51011(3) respectively for aboveground containers.
- (6) Marking of containers. Each container or group of containers shall be marked on at least two sides with the words "anhydrous ammonia" or "caution-ammonia" in sharply contrasting colors with letters not less than four inches high.

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**WAC 296-24-51011 (Cont.)**

- (7) Protection of container appurtenances.
- (a) Valves and other appurtenances shall be protected against physical damage. Main container shut-off valves shall be kept closed and locked when the installation is unattended. If the facility is protected against tampering by fencing or other suitable means, valve locks are not required.
  - (b) All connections to underground containers should be located within a substantial dome, housing or manhole fitted with a substantial removable cover. Appurtenances shall also be protected during the transit of containers intended for installation underground.
  - (c) Storage containers need not be grounded.
- (8) Identification. A sign shall be displayed in a conspicuous place stating the name, address, and phone number of the nearest representative, agent, or owner of the storage system.  
[Order 76-6, § 296-24-51011, filed 3/1/76; Order 73-5, § 296-24-51011, filed 5/9/73 and Order 73-4, § 296-24-51011, filed 5/7/73.]

**WAC 296-24-51013 Refrigerated storage.** This section applies specifically to systems utilizing tanks for the storage of anhydrous ammonia under refrigerated conditions. All basic rules of WAC 296-24-51009 apply to this section unless inconsistent with the requirements of this section.

- (1) Design of tanks.
- (a) Tanks may be designed for any storage pressure desired as determined by economical design of the refrigerated system.
  - (b) The design temperature shall be the minimum temperature to which the container will be refrigerated and shall be so designated.
  - (c) Containers with a design pressure exceeding 15 p.s.i.g. shall be constructed in accordance with WAC 296-24-51009(2) and the material shall be selected from those listed in API Standards 620, 4<sup>th</sup> edition 1970, Recommended Rules for Design and Construction of Large, Welded Low-Pressure Storage Tanks, Tables 2.02, R.2.1, R.2.2, R.2.3 or R.2.4.
  - (d) Tanks with a design pressure of 15 p.s.i.g. and less shall be constructed in accordance with the general requirements of API Standard 620, 4<sup>th</sup> edition, 1970, including Appendix R.
  - (e) When austenitic steels or nonferrous materials are used, the ASME Code shall be used as a guide in selection of materials for use at the design temperature.
  - (f) The filling density for refrigerated storage containers shall be such that the container will not be liquid full at a liquid temperature corresponding to the vapor pressure at the start-to-discharge pressure setting of the safety-relief valve. (New 1-22-76)
- (2) Installation of storage tanks.
- (a) Tanks shall be supported on suitable noncombustible foundations designed to accommodate the type of tank being used.
  - (b) Adequate protection against flotation or other water damage shall be provided wherever high flood water might occur.

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**WAC 296-24-51013 (Cont.)**

- (c) Tanks for product storage at less than 32°F shall be supported in such a way, or heat shall be supplied, to prevent the effects of freezing and consequent frost heaving.
  - (d) The area surrounding a refrigerated tank or group of tanks shall be provided with drainage, or shall be diked to prevent accidental discharge of liquid from spreading to uncontrolled areas.
  - (e) When drainage is employed, a slope of not less than one percent shall be provided. The drainage system shall terminate in an impounding basin having a capacity as large as the largest tank served.
  - (f) Provision shall be made for drainage of rain water from the diked or impounding area. Such drainage shall not permit the release of ammonia.
  - (g) When a dike surrounding the tank is employed, the capacity of the diked enclosure shall be as large as the largest tank served.
  - (h) The walls of a diked enclosure or the wall of an impounding basin used in a drainage system shall be of earth, steel or concrete designed to be liquid tight and to withstand the hydrostatic pressure and the temperature. Earth walls shall have a flat top at least 2 feet wide. The slope shall be stable and consistent with the angle of repose of the earth used.
  - (i) The ground in an impounding basin or within a diked enclosure, should be graded so that small spills, or the early part of a large spill, will accumulate at one side or corner contacting a relatively small area of ground and exposing a relatively small surface area for heat gain. Shallow channels in the ground surface or low curbs of earth can help guide the liquid to these low areas without contacting a large ground area.
- (3) Marking refrigerated containers.
- Each refrigerated container shall be marked with a nameplate on the outer covering in an accessible place as specified in the following:
- (a) With the name and address of the builder and the date of fabrication.
  - (b) With the maximum volume or weight of the product whichever is most meaningful to user.
  - (c) With the design pressure.
  - (d) With the minimum temperature in degrees Fahrenheit for which the container was designed.
  - (e) With the maximum allowable water level to which the container may be filled for the test purposes.
  - (f) With the density of the product in pounds per cubic foot for which the container was designed.
  - (g) With the maximum level to which the container may be filled with liquid anhydrous ammonia.
- (4) Tank valves, fill pipes and discharge pipes.
- (a) Shut-off valves shall be:

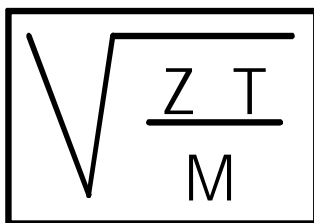
**WAC 296-24-51013 (Cont.)**

- (i) Provided for all connections except those with a No. 54 drill size restriction, plugs, safety valves, thermometer wells, and
    - (ii) Located as close to the tank as practicable.
  - (b) When operating conditions make it advisable, a check valve shall be installed on the fill connection and a remotely operated shut-off valve on other connections located below the maximum liquid level.
- (5) Safety relief devices.
- (a) Safety relief valves shall be set to start-to-discharge at a pressure not in excess of the design pressure of the tank and shall have a total relieving capacity sufficient to prevent a maximum pressure in a tank of more than one hundred twenty percent of the design pressure.
  - (b) The total relieving capacity shall be the larger requirement of (b)(i) or (ii) of this subsection.
    - (i) Possible refrigeration system upset such as (A) cooling water failure, (B) power failure, (C) instrument air or instrument failure, (D) mechanical failure of any equipment, (E) excessive pumping rates, (F) changing atmospheric conditions.
    - (ii) Either one of the following formulas for fire exposure, (A) for valve manufacturers who use weight of vapors to be relieved as basis for classifying valves:

$$W = \frac{34,500 F A^{0.82}}{L}$$

or (B) for valve manufacturers that classify valves on the basis of air flow:

$$Q_a = \frac{633,000 F A^{0.82}}{L C}$$



Where

- W = weight of vapors to be relieved in pounds/hour at relieving conditions;
- Q<sub>a</sub> = air flow in cubic feet per minute at standard conditions (60F and 14.7 psi);
- F = fireproofing credit. Use F = 1.0 except when an approved fireproofing material of recommended thickness is used, then use F = 0.2.

**WAC 296-24-51013 (Cont.)**

- A = total surface area in square feet up to 25 feet above grade or to the equator of a sphere, whichever is greater;  
 Z = compressibility factor of ammonia at relieving conditions (if not known, use  $Z = 1.0$ );  
 T = temperature in degrees R ( $460 +$  temperature in degrees F of gas at relieving conditions);  
 M = molecular weight = 17 for ammonia;  
 L = latent heat of ammonia at relieving conditions;  
 C = constant based on relation of specific heats. (C may be obtained from the following table.)  
 (If K is not known use  $C = 315$ .)

K	C	K	C	K	C
1.00	315	1.26	343	1.52	366
1.02	318	1.28	345	1.54	368
1.04	320	1.30	347	1.56	369
1.06	322	1.32	349	1.58	371
1.08	324	1.34	351	1.60	372
1.10	327	1.36	352	1.62	374
1.12	329	1.38	354	1.64	376
1.14	331	1.40	356	1.66	377
1.16	333	1.42	358	1.68	379
1.18	335	1.44	359	1.70	380
1.20	337	1.46	361	2.00	400
1.22	339	1.48	363	2.20	412
1.24	341	1.50	364		

Where  $K = C_p/C_v$  at atmospheric conditions and

$C_p$  = specific heat of vapor at constant pressure.

$C_v$  = specific heat of vapor at constant volume.

- (c) Shut-off valves of adequate flow capacity may be provided and used to facilitate inspection and repair of safety relief valves. When a shut-off valve is provided it shall be so arranged that it can be locked or sealed open, and it shall not be closed except by an authorized person who shall remain stationed there while the valve remains closed, and who shall again lock or seal the valve open when leaving the station.
- (d) Safety relief devices shall comply with the following:
- (i) If stacks are used they shall be suitably designed to prevent obstruction by rain, snow, ice or condensate. The outlet size shall not be smaller than the nominal size of the safety relief valve outlet connection.
  - (ii) Discharge lines may be used if desired. Multiple safety relief valves on the same storage unit may be run into a common discharge header. The discharge line and header shall be designed to accommodate the maximum flow and a back pressure not exceeding ten percent of the design pressure of the storage container. This back pressure shall be included in the one hundred twenty percent total maximum pressure given in (a) of this subsection. No other container or system shall exhaust into this discharge line or header. The vent lines shall be installed to prevent accumulation of liquid in the lines.
- (e) Atmospheric storage shall be provided with vacuum breakers. Ammonia gas may be used to provide a pad.

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**WAC 296-24-51013 (Cont.)**

- (6) Protection of container appurtenances. Refrigerated storage containers shall comply with the provisions of WAC 296-24-51011(7).
- (7) Reinstallation of containers. Containers of such size as to require field fabrication shall, when moved and reinstalled, be reconstructed and reinspected in complete accordance with the code under which they were constructed. The containers shall be subjected to a pressure retest, and if rerating is necessary, it shall be done in accordance with the applicable code pressures.
- (8) Damage from vehicles. Precaution shall be taken to avoid any damage by trucks, tractors, or other vehicles.
- (9) Refrigeration load and equipment.
  - (a) The total refrigeration load shall be computed as the sum of the following:
    - (i) Load imposed by heat flow into the container caused by the temperature differential between the ambient temperature and the design storage temperature.
    - (ii) Load imposed by heat flow into the tank caused by maximum sun radiation.
    - (iii) Maximum load imposed by filling the tank with ammonia warmer than the design storage temperature.
  - (b) More than one storage tank may be handled by the same refrigeration system.
  - (c) Compressors. (See also WAC 296-24-51009 (12)(g).)
    - (i) A minimum of two compressors shall be provided, either of which is of sufficient size to handle the loads listed in (a)(i) and (ii) of this subsection. Where more than two compressors are provided, minimum standby equipment equal to the largest normally operating equipment shall be installed. Compressors required for (a)(iii) of this subsection may be used as standby equipment for compressors required in (a)(i) and (ii) of this subsection.
    - (ii) Compressors shall be sized to operate with a suction pressure at least ten percent below the minimum setting of the safety relief valve(s) on the storage tank and shall withstand a suction pressure at least equal to one hundred twenty percent of the design pressure of the tank. Discharge pressure will be governed by condensing conditions.
  - (d) Compressor drives.
    - (i) Each compressor shall have its individual driving unit.
    - (ii) Any standard drive consistent with good design may be used.
    - (iii) An emergency source of power of sufficient capacity to handle the loads listed in (a)(i) and (ii) of this subsection shall be provided, unless facilities are provided to safely dispose of vented vapors while the refrigeration system is not operating.
  - (e) Automatic control equipment.

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**WAC 296-24-51013 (Cont.)**

- (i) The refrigeration system shall be arranged with suitable controls to govern the compressor operation in accordance with the load as evidenced by the pressure in the container(s).
  - (ii) An emergency alarm system shall be installed to function in the event the pressure in the container(s) rises to the maximum or falls to the minimum allowable operating pressure.
  - (iii) An emergency alarm and shut-off shall be located in the condenser system to respond to excess discharge pressure caused by failure of the cooling medium.
  - (iv) All automatic controls shall be installed in a manner to preclude operation of alternate compressors unless the controls will function with the alternate compressors.
- (f) Separators.
- (i) An entrainment separator of suitable size and design pressure shall be installed in the compressor suction line. The separator shall be equipped with a drain and gaging device.
  - (ii) An oil separator of suitable size shall be installed in the compressor discharge line. It shall be designed for at least 250 p.s.i.g. and shall be equipped with a gaging device and drain valve.
- (g) Condensers. The condenser system may be cooled by air or water or both. The condenser shall be designed for at least 250 p.s.i.g. Provision shall be made for purging noncondensibles either manually or automatically.
- (h) Receiver and liquid drain. A receiver shall be provided which is equipped with an automatic float valve to discharge the liquid ammonia to storage or with a high pressure liquid drain trap of suitable capacity. The receiver shall be designed for at least 250 p.s.i.g. operating pressure and be equipped with the necessary connections, safety relief valves and gaging device.
- (i) Insulation. Refrigerated containers and pipe lines which are insulated shall be covered with a material of suitable quality and thickness for the temperatures encountered. Insulation shall be suitably supported and protected against the weather. Weatherproofing shall be of a type which will not support flame propagation.
- (10) Safety equipment. All refrigerated storage plants shall have on hand the minimum safety equipment required under WAC 296-24-51009 (10)(c).

[Statutory Authority: Chapter 49.17 RCW. 88-23-054 (Order 88-25), § 296-24-51013, filed 11/14/88. Statutory Authority: RCW 49.17.040, 49.17.050, 49.17.240, chapters 43.22 and 42.30 RCW. 80-17-015 (Order 80-21), § 296-24-51013, filed 11/13/80; Order 76-6, § 296-24-51013, filed 3/1/76; Order 73-5, § 296-24-51013, filed 5/9/73 and Order 73-4, § 296-24-51013, filed 5/7/73.]

**WAC 296-24-51015 Systems utilizing portable DOT containers.** This section applies specifically to systems utilizing cylinders, portable tanks (DOT-51), or “ton containers” (DOT-106A, DOT-110A), constructed in accordance with department of transportation specifications. All basic rules of WAC 296-24-51009 apply to this section, unless otherwise noted.

- (1) Containers.
- (a) Containers shall comply with department of transportation specifications and shall be maintained, filled, packaged, marked, labeled and shipped to comply with current DOT regulations and American National Standard Method of Marking Portable Compressed Gas Containers to Identify the Material Contained, Z48.1. (See Appendix C for availability.)

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**WAC 296-24-51015 (Cont.)**

- (b) Containers shall be stored in an area free from ignitable debris and in such manner as to prevent external corrosion. (Storage may be indoors or outdoors.)
  - (c) Containers shall not be buried below ground.
  - (d) Containers shall be set upon firm foundations or otherwise firmly secured. The possible effect of settling on the outlet piping shall be guarded against by a flexible connection or special fitting.
  - (e) Containers shall be protected from heat sources such as radiant flame and steam pipes. Do not apply heat directly to containers to raise the pressure.
  - (f) Containers shall be stored in such manner as to protect them from moving vehicles or external damage.
  - (g) Any container which is designed to have a valve protection cap shall have the cap securely in place when the container is not in service.
- (2) Container valves and regulating equipment.
- (a) Container valves and pressure regulating equipment shall be protected against tampering when installed for use.
  - (b) Container valves shall be protected while in transit, in storage, and while being moved into final utilizations, as follows:
    - (i) By setting them into a recess of the container, or
    - (ii) By ventilated cap or collar, fastened to the container, capable of withstanding a blow from any direction equivalent to that of a 30-lb. weight dropped four feet. Construction must be such that a blow will not be transmitted to the valves or other connections.
  - (c) When containers are not connected for service, the outlet valves shall be kept tightly closed even though containers are considered empty.
- (3) Safety relief devices. Containers shall be provided with safety relief devices as required by department of transportation regulations.

[Order 73-5, § 296-24-51015, filed 5/9/73 and Order 73-4, § 296-24-51015, filed 5/7/73.]

**WAC 296-24-51017 Systems mounted on trucks, semi-trailers, and trailers for transportation of ammonia.** This section applies specifically to systems mounted on trucks, semi-trailers and trailers (other than those covered under WAC 296-24-51019 and 296-24-51021) used for the transportation of ammonia. All basic rules of WAC 296-24-51009 apply to this section unless otherwise noted. Systems for trucks and trailers for transportation of anhydrous ammonia, in addition to complying with the requirements of these standards, shall also comply where required, with the requirements of the department of transportation and those of any other regulatory body which may apply.

- (1) Design pressure of containers.
- (a) Containers used in intrastate commerce shall be constructed in accordance with WAC 296-24-51009(2) with a minimum design pressure of 250 psig. Containers used in interstate commerce shall meet DOT regulations.
  - (b) The shell or head thickness of any container shall not be less than 3/16 inch.



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**WAC 296-24-51017 (Cont.)**

- (c) All container openings, except safety relief valves, liquid level gaging devices and pressure gages, shall be labeled to designate whether they communicate with liquid or vapor space. Labels may be on valves.
  - (d) Baffles are not required for cargo tanks.
- (2) Mounting containers on truck.
  - (a) The means of attachment of any container to the cradle, frame or chassis of a vehicle shall be designed on a basis of two "g" loading in either direction, using a safety factor of not less than 4, based on the ultimate strength of the material used. For purposes of this requirement, two "g" of load support is equivalent to three times the static weight of the articles supported; two "g" of loading and bending, acceleration, and torsion is equivalent to twice the static weight support applied horizontally at the road surface.
  - (b) "Hold-down" devices, when used, shall anchor the container to the cradle, frame or chassis in a suitable and safe manner that will not introduce undue concentration of stresses. These devices shall incorporate positive means for drawing the container down tight, and suitable stops or anchors shall be provided to prevent relative movement between container and framing due to stopping, starting or changes in direction.
  - (c) Vehicles designed and constructed so that the cargo tanks constitute in whole or in part the stress member used in lieu of the frame shall be supported by external cradles suspending at least 120° of the shell circumference. The design calculation shall include beam stress, shear stress, torsion stress, bending moment and acceleration stress, in addition to those covered by the code under which the cargo tank was designed.
  - (d) If a liquid withdrawal line is installed in the bottom of a container, the connections thereto, including hose, shall not be lower than the lowest horizontal edge of the trailer axle.
  - (e) Provisions shall be made to secure both ends of the hose while in transit.
  - (f) When the cradle and the container are not welded together, suitable material shall be used between them to eliminate metal-to-metal friction.
- (3) Container appurtenances.
  - (a) Nonrecessed container fittings and appurtenances shall be protected against physical damage by either: (i) A protected location, (ii) the vehicle frame or bumper, or (iii) a protective housing. The protective housing, if used, shall comply with the requirements under which the containers are fabricated with respect to design and construction, and shall be designed to withstand static loadings in any direction equal to twice the weight of the container and attachments when filled with the lading using a safety factor of not less than 4, based on the ultimate strength of the material to be used. The protective housing if used shall be protected with a weather cover, if necessary, to insure proper operation of valves and safety relief devices.
  - (b) All connections to containers, except filling connections (see WAC 296-24-51017 (3)(c)), safety relief devices, and liquid level and pressure gage connections, shall be provided with suitable automatic excess flow valves, or in lieu thereof, may be fitted with quick-closing internal valves, which shall remain closed except during delivery operations. The control mechanism for such valves may be provided with a secondary control remote from the delivery connections and such control mechanism shall be provided with a fusible section (melting point 208F to 220F) which will permit the internal valve to close automatically in case of fire.

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**WAC 296-24-51017 (Cont.)**

- (c) Filling connections shall be provided with automatic back-pressure check valves, excess-flow check valves, or quick-closing internal valves, to prevent back-flow in case the filling connection is broken. Where the filling and discharge connect to a common opening in the container shell and that opening is fitted with a quick-closing internal valve as specified in WAC 296-24-51017 (3)(b), the automatic valve shall not be required.
- (d) All containers shall be equipped for spray loading (filling in the vapor space) or with an approved vapor return valve of adequate capacity.
- (e) All containers shall be equipped with a fixed maximum liquid level gage.
- (f) All containers shall be equipped with a pressure-indicating gage having a dial graduated from 0-400 psig.
- (4) Piping and fittings.
  - (a) All piping, tubing and fittings shall be securely mounted and protected against physical damage.
  - (b) Piping used on nonrefrigerated systems shall be at least ASTM A-53 Grade B electric resistance welded and electric flash welded pipe or equal. Such pipe shall be at least Schedule 40 when joints are welded, or welded and flanged. Such pipe shall be at least Schedule 80 when joints are threaded. Brass, copper, or galvanized steel pipe or tubing shall not be used.
  - (c) The truck unloading line shall be provided with an excess flow valve at the hose connection unless an approved quick closing internal valve is provided in the container unloading connection. (See WAC 296-24-51017 (3)(b).)
- (5) Safety relief devices. The discharge from container safety relief valves shall be vented away from the container upward and unobstructed to the open air in such a manner as to prevent any impingement of escaping gas upon the container; loose fitting rain caps shall be used. Size of discharge lines from safety relief valves shall not be smaller than the nominal size of the safety relief valve outlet connection. Suitable provision shall be made for draining condensate which may accumulate in the discharge pipe.
- (6) Marking of container. Every container, whether loaded or empty, shall be conspicuously and legibly marked on each side and rear thereof on a background of sharply contrasting color with the words "COMPRESSED GAS" in letters at least four inches high; or with the words "ANHYDROUS AMMONIA" in letters at least four inches high; or in compliance with department of transportation regulations.
- (7) Transfer of liquids.
  - (a) The content of tank motor vehicle containers shall be determined by weight, by suitable liquid level gaging devices, meters, or other approved methods.

*Note: If the content of a container is to be determined by liquid level measurement, the container shall have a thermometer well so that the internal liquid temperature can be easily determined. This volume when converted to weight shall not exceed the filling density specified by the department of transportation regulations.*

- (b) Pumps or compressors shall be designed and installed in accordance with WAC 296-24-51009(12) and protected against physical damage when mounted upon ammonia tank trucks and trailers.
- (c) Tank motor vehicles of greater than 3500 water gallons capacity shall be unloaded only at approved locations meeting the requirements of WAC 296-24-51009 (10)(c) and (12)(h).

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**WAC 296-24-51017 (Cont.)**

- (8) Electrical equipment and lighting. Tank trucks, tank trailers, and tank semi-trailers, may not be equipped with any artificial light other than electric light. Electric lighting circuits shall have suitable overcurrent protection (fuses or automatic circuit breakers). The wiring shall have sufficient carrying capacity and mechanical strength, and shall be suitably secured, insulated and protected against physical damage.
- (9) Chock blocks. At least two chock blocks shall be provided. These blocks shall be placed to prevent rolling of the vehicle whenever it is parked during loading and unloading operations.
- (10) Portable tanks (including skid tanks). When portable tanks are used in lieu of cargo tanks and are permanently mounted on tank motor vehicles for the transportation of ammonia, they shall comply with the requirements of WAC 296-24-51017. Where portable tanks, including those built to DOT Specification 51, 106A or 110A, are used for farm storage they shall comply with WAC 296-24-51011. When portable tanks are used as shipping containers in interstate commerce they shall comply with WAC 296-24-51015.
- (11) Safety equipment.
  - (a) All tank trucks, trailers, and semi-trailers should be equipped with the following for emergency and rescue purposes:
    - (i) One full face gas mask with anhydrous ammonia refill canisters.
    - (ii) One pair of protective gloves made of rubber or other material impervious to ammonia.
    - (iii) Tight-fitting goggles or one full face shield.
    - (iv) A container of not less than five gallons of readily available clean water.

*\*An ammonia canister is effective for short periods of time in light concentrations of ammonia vapor, generally 15 minutes in concentrations of 3% and will not protect breathing in heavier concentrations. If ammonia vapors are detected when mask is applied the concentration is too high for safety. The life of a canister in service is controlled by the percentage of vapors to which it is exposed. Canisters must not be opened until ready for use and should be discarded after use. Unopened canisters may be guaranteed for as long as three years. All should be dated when received because of this limited life. In addition to this protection, an independently supplied air mask of the type used by fire departments may be used for severe emergencies.*

[Statutory Authority: RCW 49.17.010, .040, .050. 99-17-094 (Order 99-01), § 296-24-51017, filed 08/17/99, effective 12/01/99. Statutory Authority: RCW 49.17.040, 49.17.050, 49.17.240, chapters 43.22 and 42.30 RCW. 80-17-015 (Order 80-21), § 296-24-51017, filed 11/13/80; Order 76-6, § 296-24-51017, filed 3/1/76; Order 73-5, § 296-24-51017, filed 5/9/73 and Order 73-4, § 296-24-51017, filed 5/7/73.]

**WAC 296-24-51019 Systems mounted on farm wagons (implements of husbandry) for the transportation of ammonia.** This section applies to containers of 3000 gallons capacity or less and pertinent equipment mounted on farm wagons (implements of husbandry) and used for the transportation of ammonia. All basic rules of WAC 296-24-51009 apply to this section unless otherwise noted.

- (1) Design of containers. Containers shall be constructed in accordance with WAC 296-24-51009(2).
- (2) Mounting containers.
  - (a) A suitable “stop” or “stops” shall be mounted on the farm wagon or on the container in such a way that the container shall not be dislodged from its mounting due to farm wagon coming to a sudden stop.

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**WAC 296-24-51019 (Cont.)**

- (b) A suitable “hold-down” device shall be provided which will anchor the container to the farm wagon at one or more places on each side of the container.
  - (c) When containers are mounted on four-wheel farm wagons, care shall be taken to insure that the weight is distributed evenly over both axles.
  - (d) When the cradle and the container are not welded together, suitable material shall be used between them to eliminate metal-to-metal friction.
- (3) Container appurtenances.
  - (a) All containers shall be equipped with a fixed maximum liquid level gage.
  - (b) All containers with a capacity exceeding 250 gallons shall be equipped with a pressure gage having a dial graduated from 0-400 psi.
  - (c) The filling connection shall be fitted with combination back-pressure check valve and excess-flow valve; one double or two single back-pressure check valves; or a positive shut-off valve in conjunction with either an internal back-pressure check valve or an internal excess flow valve.
  - (d) All containers with a capacity exceeding 250 gallons shall be equipped for spray loading or with an approved vapor return valve.
  - (e) All vapor and liquid connections, except safety relief valves and those specifically exempt in WAC 296-24-51009 (6)(e), shall be equipped with approved excess flow valves or may be fitted with quick-closing internal valves which, except during operating periods, shall remain closed.
  - (f) Fittings shall be protected from physical damage by means of a rigid guard designed to withstand static loading in any direction equal to twice the weight of the container and lading using a safety factor of four based upon the ultimate strength of the material used. If the guard is fully enclosed, the safety relief valves shall be properly vented through the guard.
  - (g) If a liquid withdrawal line is installed in the bottom of a container, the connections thereto, including hose, shall not be lower than the lowest horizontal edge of the farm wagon axle.
  - (h) Both ends of the hose shall be made secure while in transit.
- (4) Marking of container. There shall appear on each side and on the rear end of the container in letters at least four inches high, the words “**anhydrous ammonia**” or, “**caution-ammonia**” or the container shall be marked in accordance with department of transportation regulations.
- (5) Farm wagons (implements of husbandry).
  - (a) Farm wagons (implements of husbandry) shall conform with state regulations.
  - (b) All farm wagons shall be securely attached to the vehicle drawing them by means of drawbars supplemented by suitable safety chains.
  - (c) A farm wagon shall be constructed so that it will follow substantially in the path of the towing vehicle and will prevent the towed farm wagon from whipping or swerving dangerously from side to side.

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**WAC 296-24-51019 (Cont.)**

(d) All farm wagons shall have five gallons or more of readily available clean water.  
[Order 73-5, § 296-24-51019, filed 5/9/73 and Order 73-4, § 296-24-51019, filed 5/7/73.]

**WAC 296-24-51021 Systems mounted on farm equipment (implements of husbandry) for the application of ammonia.** This section applies to systems mounted on farm equipment and used for the field application of ammonia. All basic rules of WAC 296-24-51009 apply to this section unless otherwise noted.

- (1) Design of containers. The minimum design for containers shall be in accordance with WAC 296-24-51009(2).
- (2) Mounting of containers. All containers shall be securely mounted.
- (3) Container valves and appurtenances.
  - (a) Each container shall have a fixed maximum liquid-level gage.
  - (b) The filling connection shall be fitted with combination back-pressure check valve and excess-flow valve; one double or two single back-pressure check valves; or a positive shut-off valve in conjunction with either an internal back-pressure check valve or an internal excess-flow valve.
  - (c) An excess-flow valve is not required in the vapor connection, provided the controlling orifice is not in excess of seven-sixteenths of an inch in diameter and the valve is hand-operated (attached hand wheel or equivalent) shut-off valve. To assist in filling applicator tanks, it is permissible to bleed vapors to the open air, providing the preceding requirements are met.
  - (d) Metering devices may be connected directly to the tank withdrawal valve. A union type connection is permissible between the tank valve and metering device. Remote mounting of metering devices is permissible using hose which meets with specifications set out in Appendix B. When the applicator tank is trailed and the metering device is remotely mounted, such as on the tractor tool bar, an automatic break-a-way type, self-closing, coupling must be used.
  - (e) No excess-flow valve is required in the liquid withdrawal line provided the controlling orifice between the contents of the container and the outlet of the shut-off valve (see WAC 296-24-51009 (6)(b)) does not exceed 7/16 inch in diameter.

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**WAC 296-24-51021 (Cont.)**

**APPENDIX A**

<b>Surface Area sq. ft.</b>	<b>Flow Rate CFM Air</b>
20	258
25	310
30	360
35	408
40	455
45	501
50	547
55	591
60	635
65	678
70	720
75	762
80	804
85	845
90	885
95	925
100	965
105	1,010
110	1,050
115	1,090
120	1,120
125	1,160
130	1,200
135	1,240
140	1,280
145	1,310
150	1,350
155	1,390
160	1,420
165	1,460
170	1,500
175	1,530
180	1,570
185	1,600
190	1,640
195	1,670
200	1,710
210	1,780
220	1,850
230	1,920
240	1,980
250	2,050
260	2,120

WAC 296-24-51021 (Cont.)

270	2,180
280	2,250
290	2,320
300	2,380
310	2,450
320	2,510
330	2,570
340	2,640
350	2,700
360	2,760
370	2,830
380	2,890
390	2,950
400	3,010
450	3,320
500	3,620
550	3,910
600	4,200
650	4,480
700	4,760
750	5,040
800	5,300
850	5,590
900	5,850
950	6,120
1,000	6,380
1,050	6,640
1,100	6,900
1,150	7,160
1,200	7,410
1,250	7,660
1,300	7,910
1,350	8,160
1,400	8,410
1,450	8,650
1,500	8,900
1,550	9,140
1,600	9,380
1,650	9,620
1,700	9,860
1,750	10,090
1,800	10,330
1,850	10,560
1,900	10,800
1,950	11,030
2,000	11,260
2,050	11,490
2,100	11,720
2,150	11,950

**WAC 296-24-51021 (Cont.)**

2,200	12,180
2,250	12,400
2,300	12,630
2,350	12,850
2,400	13,080
2,450	13,300
2,500	13,520

Surface area = total outside surface area of container in square feet. When the surface area is not stamped on the name plate or when the marking is not legible, the area can be calculated by using one of the following formulas:

- (1) Cylindrical container with hemispherical heads

Area = overall length in feet times outside diameter in feet times 3.1416.

- (2) Cylindrical container with other than hemispherical heads

Area = (overall length in feet plus 0.3 outside diameter in feet) times outside diameter in feet times 3.1416.

- (3) Spherical container

Area = outside diameter in feet squared times 3.1416.

Flow rate--CFM air = cubic feet per minute of air required at standard conditions, 60F and atmospheric pressure (14.7 psia).

The rate of discharge may be interpolated for intermediate values of surface area. For containers with total outside surface area greater than 2,500 sq. ft., the required flow rate can be calculated using the formula, flow rate CFM air =  $22.11 A^{0.82}$  where A = outside surface area of the container in square feet.

**APPENDIX B**  
**TFI-RMA SPECIFICATION FOR ANHYDROUS AMMONIA HOSE**  
**TFI-RMA STANDARD NO. M-5**

- (1) **Scope.** This specification covers hose and hose assemblies commonly referred to as "pressure transfer hose," used to convey anhydrous ammonia liquid or to convey anhydrous ammonia gas where the gas is in contact with liquid ammonia. This specification primarily covers hose and hose assemblies which have a minimum burst pressure of 1750 psig, a safety factor of 5, and a maximum working pressure of 350 psig. These figures should not be misconstrued to mean that they are the maximum pressures to which anhydrous ammonia hose and hose assemblies are built, since higher pressure hose and hose assemblies are available for special applications.
- (2) **Sizes and tolerances.** Anhydrous ammonia hose shall be made with the following dimensions and tolerances:

**Rubber Covered Hose For Use With  
Two-Piece Screw Type Couplings**

<b>I.D.</b>	<b>Tolerance</b>	<b>O.D.</b>	<b>Tolerance</b>
1/2"	± 1/32"	15/16"	± 1/32"
3/4"	± 1/32"	1 1/4"	± 1/32"
1"	± 1/16"	1 1/2"	± 1/16"



**WAC 296-24-51021 (Cont.)**

**Nonrubber Covered Hose and Rubber Covered Hose  
For Use With Full Flow Couplings**

<b>I.D.</b>	<b>Tolerance</b>		<b>O.D.</b>	<b>Tolerance</b>	<b>Nominal Tubing O.D.</b>
13/32"	+.039"	.015"	49/64"	± .031"	1/2"
1/2"	+.047"	.015"	59/64"	± .031"	5/8"
5/8"	+.047"	.015"	1 5/64"	± .031"	3/4"
7/8"	+.047"	.015"	1 15/64"	± .031"	1"
1 1/8"	+ 0.62"	.015"	1 1/2"	± .047"	1 1/4"
1 3/8"	+0.62"	.015"	1 3/4"	± .047"	1 1/2"
1 13/16"	+0.62"	.015"	2 7/32"	± .047"	2"

**Hose For Use With Other Types of Couplings\***

<b>I.D.</b>	<b>Tolerance</b>
1/2"	± 1/32"
3/4"	± 1/32"
1"	± 1/16"
1 1/4"	± 1/16"
1 1/2"	± 1/16"
2"	± 1/16"

*\*The O.D. dimension and tolerance were intentionally omitted from this tabulation to provide for developments in both hose and couplings.*

(3) Construction.

- (a) Inner tube. The tube shall be uniform in quality and thickness and free from injurious defects. It shall meet the physical requirements of (4) of Appendix B. The material shall be resistant to hardening or other deterioration due to the action of ammonia.
- (b) Reinforcement. The reinforcement shall consist of any material not adversely affected by permeating ammonia. The reinforcement shall be applied evenly and uniformly, and in such a way that it will meet the physical requirements of (4) of Appendix B. In constructions utilizing a ply or plies of wire reinforcement, the composition of the wire shall be a suitable corrosion resistant stainless steel.
- (c) Cover. A rubber cover if used shall be uniform in quality and thickness and free from injurious defects. It shall meet the physical requirements of (4) of Appendix B. The cover shall be so compounded or constructed that it will not blister in service, and will be resistant to deterioration due to the action of ammonia. A gas tight cover shall be pricked to relieve pressure build-up between inner tube and cover. The cover shall be resistant to deterioration due to exposure to the elements.

(4) Physical tests.

- (a) Tension test of tube and cover.

	<b>Tube</b>	<b>Cover</b>
Tensile, psi. min.	800	1200
Elongation, percent, min.	150	200

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**WAC 296-24-51021 (Cont.)**

- (b) Adhesion test
- |                   |      |     |       |
|-------------------|------|-----|-------|
|                   | Tube | Ply | Cover |
| Adhesion lbs./in. | 10   | 8   | 10    |
- (i) In constructions having braided wire or woven wire filler reinforcing members, only the cover adhesion requirement will apply, as it is impractical to prepare adhesion test specimens except for determining cover adhesion.
- (c) Burst test. All sizes have a minimum burst of 1750 psig. (See scope.)
- (d) Ammonia performance test. During the conditioning and flexing described in (7)(d) and (7)(d)(ii) of Appendix B there shall be no evidence of cover blistering or leakage. At the conclusion of the conditioning and at the conclusion of the flexing test, the burst must still meet the requirements of (4)(c) of Appendix B. There shall be no evidence of separation of the component parts when the remainder of the samples are examined.
- (e) Low temperatures test. The hose shall not fail at minus 40F plus or minus 2°, when tested as described in (7)(e) of Appendix B.
- (5) Types of tests.
- (a) Acceptance inspection. This includes all the test specified, with the exception of the ammonia performance test.
- (b) Qualification tests. The qualification tests are intended to establish that the hose is properly designed and constructed to give satisfactory service life. These tests shall be conducted by a recognized independent laboratory. The qualification tests shall consist of all the tests specified herein including the ammonia performance test.
- (6) Method of sampling.
- (a) Acceptance inspection. A 24-inch sample of each size and type hose, representative of the lot, shall be selected from each lot manufactured at one time, or from each 25,000 feet, whichever is smaller.
- (b) Qualification test. In addition to the samples specified in (6)(a) of Appendix B, two 12-foot lengths of each size hose shall be selected for the ammonia performance test. Each new hose shall be subjected to a qualification test, and again whenever there has been a design change.
- (7) Methods of testing.
- (a) Tension test of tube and rubber cover. The tension test shall be made in accordance with ASTM D-380.
- (b) Friction test. The friction test shall be made in accordance with ASTM D-380.
- (c) Burst test. The burst test shall be made in accordance with ASTM D-380 using the method entitled "straight bursting test."

**WAC 296-24-51021 (Cont.)**

- (d) Ammonia performance test. Two 12-foot lengths of hose, to be marked "A" and "B" shall be filled with liquid anhydrous ammonia by connecting to a tank and flushing out with ammonia to remove all the air. One end of each length shall be sealed and the other end left connected to the liquid space of a tank of anhydrous ammonia. The hose shall then be conditioned for 14 days at ambient temperature of 60 to 100F. A valve between the ammonia tank and the hose may be closed providing it is opened at least once each day to completely fill the hose with liquid anhydrous ammonia. The hose shall be examined each day for visible defects. There shall be no evidence of the cover blistering or perceptible leakage. If the hose is valved off at each end when liquid full, a hydrostatic relief valve should be provided between the block valves.
- (i) Conditioned hose burst test. A 24-inch sample cut from hose marked "A" shall be subjected to a straight hydrostatic bursting test in accordance with (7)(c) of Appendix B.
- (ii) Conditioned hose flexing test.
- (A) The 12-foot hose length marked "B" shall be installed in flexing test machine (Fig. 1). One end of the hose is to be connected to the traveling block and the free end passed around two pulleys with diameters as shown in Table 1. A 30-pound weight shall then be attached to the free end.
- (B) From the remainder of hose length marked "A", (sizes 1 inch and under only), cut a section to length indicated in Table 1. Connect one end to the vertically traveling block as shown in Fig. 1 and connect the other end to the liquid space of a tank of anhydrous ammonia. Maintain the temperature of hose and ammonia between 70F and 90F. The test on the feeder hose does not apply to sizes over 1 inch. To conduct the flex test on the larger sizes any convenient hose may be used as a feeder hose.
- (C) The flexing test shall continue for 72 hours at a rate of approximately 470 cycles per hour with a 42-inch vertical movement of the traveling block. A valve between the ammonia tank and the hose may be closed providing it is opened at least once each day to pressurize the hose. The hose shall be examined each day for visible defect. There shall be no evidence of cover blistering or leakage.
- (D) At the conclusion of the flexing period, cut a 24-inch sample from hose "A" and from hose "B" and subject each sample to a straight burst test in accordance with (7)(c) of Appendix B. All samples shall have a minimum burst of 1750 psig.

**TABLE 1**

Hose Size	Pulley Diameter	Feeder Hose Length
1/2"	14" $\pm$ 1/4"	36"
3/4"	14" $\pm$ 1/4"	36"
1"	14" $\pm$ 1/4"	36"
1 1/4"	15" $\pm$ 1/4"	
1 1/2"	18" $\pm$ 1/4"	
2"	24" $\pm$ 1/4"	

- (E) Low temperature test. A straight piece of hose at least 24 inches long, conditioned to minus 40F plus or minus 2F for 5 hours, and bent 180° within two seconds around a mandrel 12 times the nominal inside diameter of the hose, shall not break or show cracks in the tube or cover.

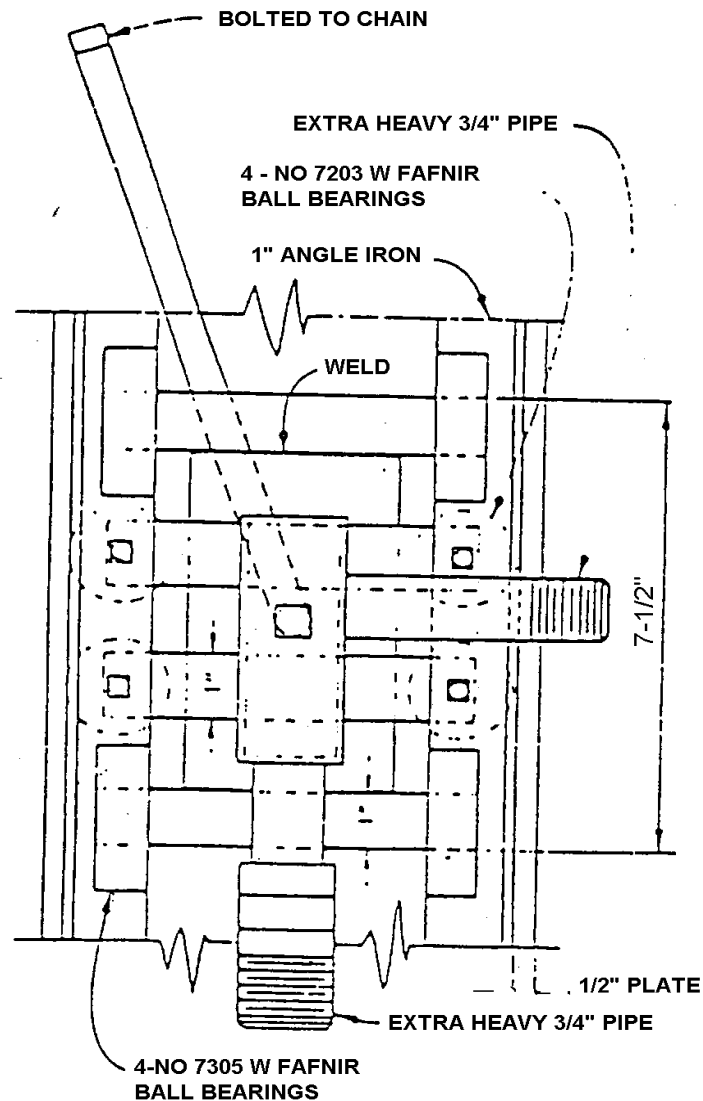
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**WAC 296-24-51021 (Cont.)**

- (8) Retests and rejections. Any hose which fails in one or more tests may be resampled and retested, for which purpose two additional samples shall be selected from the hose for the test that failed to meet the requirements. Failure of either of the retested samples shall be cause for final rejection.
- (9) Hose assemblies. The couplings must be so designed and constructed, that an assembly shall have sufficient strength that it will reach the minimum burst pressure, as required by (4)(c) of Appendix B, before the end fittings leak or come off when pressure is applied as specified in ASTM D-380 for hydrostatic tests. Fittings must be resistant to the action of anhydrous and aqueous ammonia and in no case may assemblies be supplied with copper alloy fittings.
- (10) Markings. Hose shall be clearly marked at least once every five feet with manufacturer's name or trademark, "anhydrous ammonia," the maximum working pressure in psig, year of manufacturer, and "TFI-RMA Spec.," for all hose manufactured after January 1, 1964. As indicated in the scope, the maximum working pressure must not be less than 350 psig.
- (11) Packaging.
  - (a) Packing. Unless otherwise specified, hose shall be packed in substantial commercial containers of the type, size and kind commonly used for the purpose, so constructed as to insure acceptance and safe delivery to common or other carriers, at the lowest rate, to the point of delivery specified on the order.
  - (b) Identification. Unless otherwise specified, shipping containers shall be marked with the size and quantity of hose therein, the name of the manufacturer, and the number of the order.

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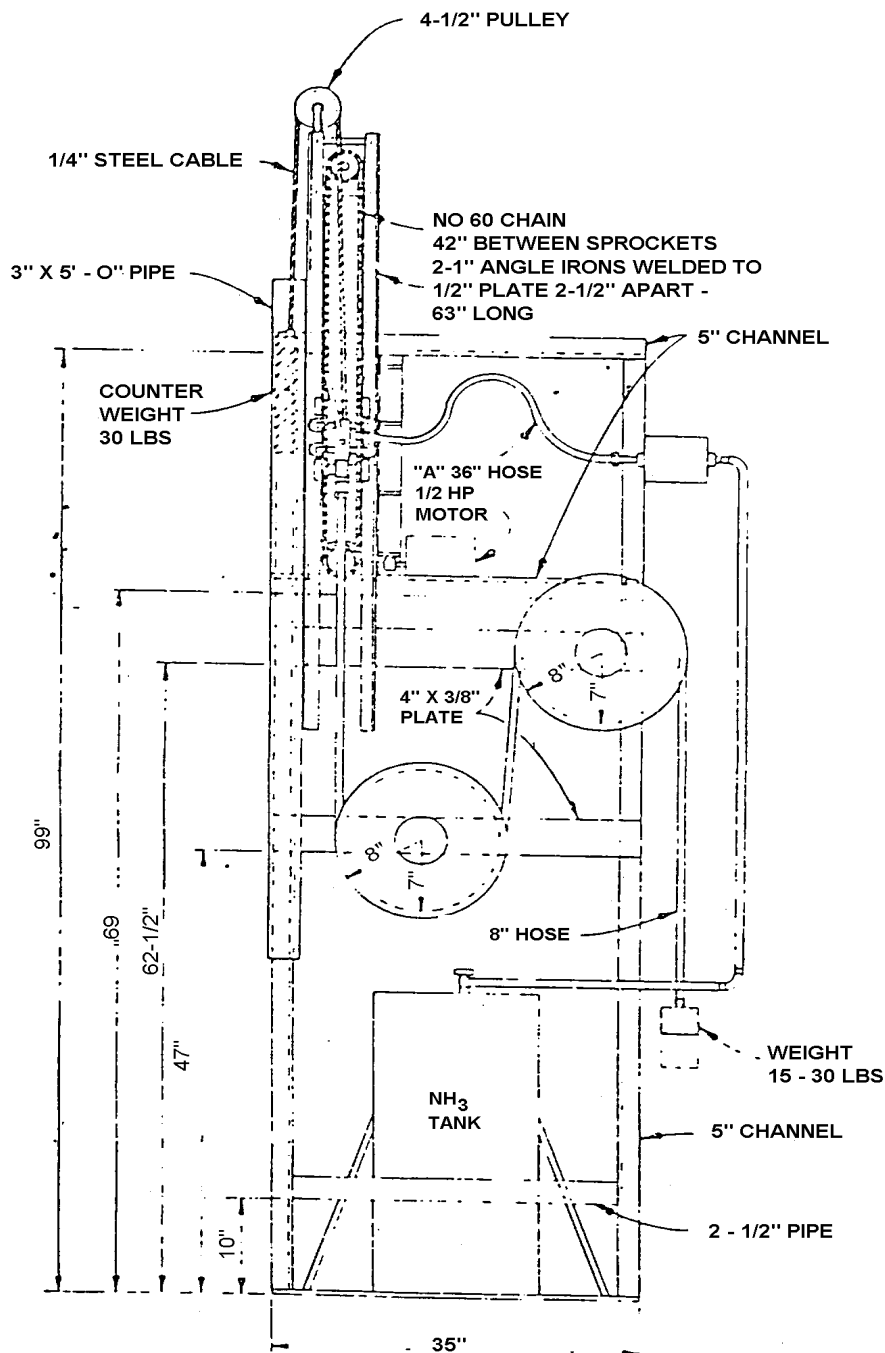
FIGURE 1



*Note: 1/2 H.P. electric motor - 1750 RPM 20:1 gear reduction unit sprockets - 14 teeth.*

**TROLLEY**

WAC 296-24-51021 (Cont.)



TYPICAL HOSE FLEXING MACHINE

[Statutory Authority: RCW 49.17.040, 49.17.050, 49.17.240, chapters 43.22 and 42.30 RCW. 80-17-015 (Order [Statutory Authority: RCW 49.17.040, 49.17.050, 49.17.240, chapters 43.22 and 42.30 RCW. 80-17-015 (Order 80-21), § 296-24-51021, filed 11/13/80; Order 73-5, § 296-24-51021, filed 5/9/73 and Order 73-4, § 296-24-51021, filed 5/7/73.]

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**WAC 296-24-51099 Appendix C-Availability of reference material.**

**APPENDIX C**

AVAILABILITY OF REFERENCE MATERIAL

American National Standards Institute, Inc. (ANSI)

[formerly United States of America Standards Institute (USASI) formerly American Standards Association (ASA)]

11 West 42<sup>nd</sup> Street

New York, New York 10036

American Petroleum Institute (API)

1220 L Street Northwest

Washington, D.C. 20005

American Society of Mechanical Engineers (ASME)

345 East 47<sup>th</sup> Street

New York, New York 10017

American Society for Testing and Materials (ASTM)

1916 Race Street

Philadelphia, Pennsylvania 19103-1187

Bureau of Explosives\*

50 "F" Street, N.W.

Washington, D.C. 20001

Compressed Gas Association, Incorporated (CGA)

1725 Jefferson Davis Highway

Arlington, Virginia 22202

The Fertilizer Institute (TFI) (formerly Agricultural Nitrogen Institute—National Plant Food Institute)

501 2<sup>nd</sup> Street Northeast

Washington, D.C. 20002

Chemical Manufacturers Association (CMA)

2501 "M" Street Northwest

Washington, D.C. 20037

National Fire Protection Association (NFPA)

Batterymarch Park

Quincy, Massachusetts 02269

Mine Safety and Health Administration

4015 Wilson Blvd.

Boston Towers, Number 3

Arlington, Virginia 22203

U.S. Government Printing Office\*

North Capitol & "H" Streets Northwest

Washington, D.C. 20401

\*DOT regulations available at nominal cost.

[Statutory Authority: Chapter 49.17 RCW. 94-15-096 (Order 94-07), § 296-24-51099, filed 7/20/94, effective 9/20/94; Order 76-6, § 296-24-51099, filed 3/1/76.]